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Conducting Discrimination Tests

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Periodically, field officials ask if it is necessary to perform a discrimination test on weighing devices outside of a laboratory environment. This article takes a closer look at the purpose of the test and how the test results are important in determining if a scale is properly set up and maintained for use in a commercial application.

A discrimination test is performed on a scale to determine if the scale has the ability to detect small changes in loads that are added to or removed from the load-receiving element. A discrimination test is warranted when scale indications are unstable (when the indicator constantly or frequently alternates between two adjacent scale divisions). Unstable indications can be a possible sign that the scale's zone of uncertainty is too wide. This can occur when the width of the zone of uncertainty exceeds the required limit of 0.3 scale division (d) as specified in NIST Handbook 44 "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices" Scales Code paragraph T.N.7.2. Discrimination; Digital Automatic Indicating. The zone of uncertainty is the portion of the weighing range between two adjacent scale divisions where an electronic scale may alternate between indicating either division value. A digital automatic indicating scale must properly determine which value to display.

The discrimination test has the added benefit of demonstrating there may be other problems with a device. For mechanical automatic indicating scales, the test is important to determine if proper repairs are being made throughout the commercial life of the device and to detect any problems with friction and binding between moving components. The inability of a mechanical scale to discriminate small changes in the applied load can affect the scale's ability to repeat indications within permissible limits specified in Handbook 44.

Handbook 44 requires a discrimination test on all automatic indicating weighing devices, except belt-conveyor scales. These Handbook 44 requirements apply to all marked and unmarked electronic digital-indicating scales (such as livestock, vehicle, and hopper scales) and mechanical automatic-indicating scales marked with an accuracy class. Separate performance requirements are specified for analog (dial, drum, fan, etc.) and digital automatic indicators. The 2006 edition of NIST Handbook 44 specifies the test loads and performance requirements for a discrimination test in the following codes:

Code	Paragraph
2.20 Scales	N.1.5. Discrimination Test T.N.7. Discrimination
2.22 Automatic Bulk Weighing Systems	N.1.5. Discrimination Test T.6. Discrimination, Digital Automatic Indicating Scales
2.24 Automatic Weighing Systems	N.2.1.4. Discrimination Test T.6. Discrimination
Paragraphs designated with N (Notes) specify the test loads for the test. Paragraphs designated with T (Tolerances) are the performance requirements for the test.	

The discrimination test is similar to the sensitivity test required for nonautomatic indicating scales. Sensitivity test criteria require devices such as weighbeams to meet requirements for a minimum change in the position of the indicating element (when starting in a rest position) in response to an increase or decrease in a specified amount of weight on the load-receiving element.

Discrimination tests are conducted in either a laboratory or field environment under controlled conditions where influence factors such as wind, rain, and vibration are eliminated or reduced to the point that they do not affect the test results. Any device installation where indicated values fluctuate several scale divisions due to influence factors should raise the question about whether the device is suitable for operation in that environment (see paragraph GUR.1.2. Environment).

The discrimination test is conducted when the scale is at equilibrium (a condition that occurs when the zero load or any other load applied to the scale results in a stable or unchanging value in the indication). The discrimination test is first conducted at or near zero load and then at a test load that is at or near capacity. In order to be able to conduct the discrimination test on a scale equipped with an automatic zero-setting mechanism[1](see note at bottom of page) (AZSM), the test is conducted at a weighing range outside of the AZSM range. For example, for a scale with a capacity of 30 pounds and a scale division (d) size of 0.01 lb, the limit of the AZSM range if the device is manufactured in January 2006 is 0.6 d; that is, the maximum amount that can be zeroed off when placed on (or removed from) the scale all at once is 0.006 lb. On this scale you would first place on the load-receiving element a test load of 1.0 d or 0.01 lb, which is outside of the 0.6 d AZSM range. Using controls on the scale for maintaining zero balance, return the display indications to zero. As a result of this procedure, the scale's AZSM feature does not continually rezero the small amount of test weights (being added and removed in increments of 0.1 d) used to conduct the discrimination test.

Test weights used to conduct the discrimination test must meet Handbook 44 Appendix A Fundamental Considerations Section 3.2 Tolerances for Standards. Test weights should be available in denominations of one-tenth of the scale division (0.1 d) to conduct the test. Figures 1 and 2 and the corresponding test procedures illustrate the test loads and steps to conduct a discrimination test. The examples given are based on a scale with a

capacity of 30 pounds and a scale division size of 0.01 lb. The principles used in these examples can be applied to other scales with different capacities and division sizes, including scales that indicate in metric units.

A test load equivalent to 1.4 d shall cause a change in indication of at least 1.0 d for analog automatic indicating scales. A scale indication that does not change by at least 1.0 d does not meet the Handbook 44 requirement for discrimination testing and will not repeat weighments within tolerance.

A test load equivalent to 1.4 d shall cause a change in indication or recorded value of at least 2.0 d for digital indicating scales. This requires the zone of uncertainty to be not greater than 0.3 d.

If you have any questions about these procedures, please contact Juana Williams by telephone at 301 975 3989 or by email at juana.williams@nist.gov.

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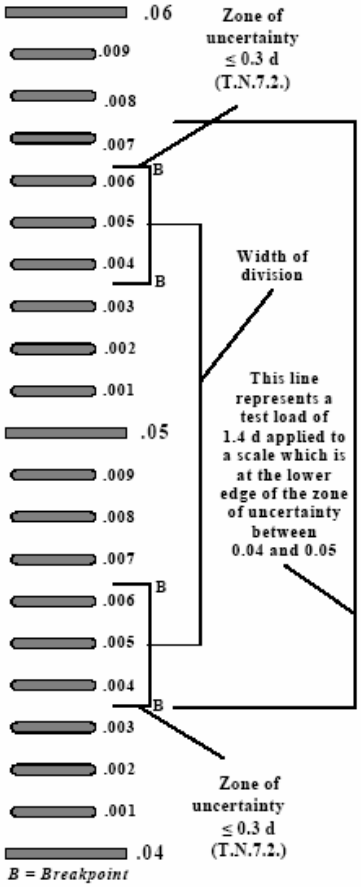
[1] Automatic zero setting mechanism (zero-tracking) (AZSM) is defined in Handbook 44 as the "automatic means provided to maintain zero balance indication without the intervention of an operator." The permissible range for setting the zero-load balance or no-load reference value for a scale is specified in Handbook 44 code paragraphs titled Zero-Load Adjustment. For example, Scales Code paragraph S.2.1.3.(a) specifies that for bench, counter, and livestock scales, manufactured between January 1, 1981 and January 1, 2007, equipped with an automatic zero-setting mechanism under normal operating conditions the maximum load that can be "rezeroed," when either placed on or removed from the platform all at once shall be 0.6 scale division.

Figure 1: Test for discrimination at or near zero load.



This example of a discrimination test at zero load is based on a scale division of 0.01 lb.

1. With the scale stable and at zero, place decimal weights on the scale equal to 1.0 d.

2. Zero the scale and place test weights equal to 5.0 d (0.05 lb) on the scale.
   - Note: The amount of test weights placed on the scale is outside of the AZSM range.

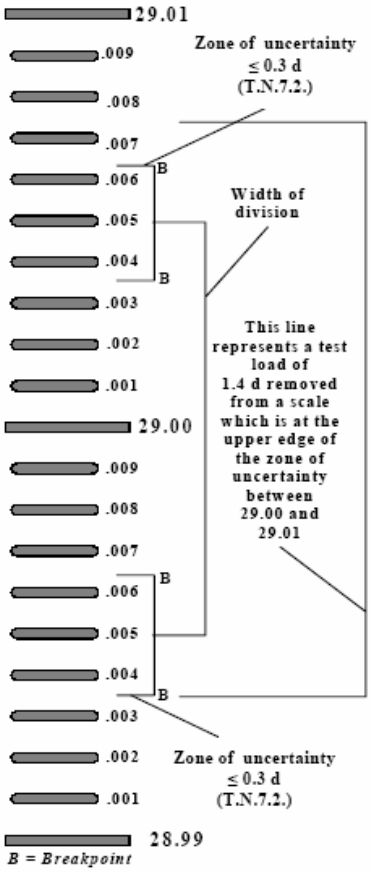
3. Remove the decimal weights in 0.1 d increments until the indication flickers between 0.04 lb and 0.05 lb.
   - If the indication does not flicker but indicates a steady 0.04 lb, add 0.1 d.
   - If the scale indicates 0.05 lb, it is at the breakpoint in the zone of uncertainty. (Remove the 0.1 d if it was used to verify the breakpoint.)

4. Add test weights equal to 1.4 d (0.014 lb) to the scale.

5. The scale passes if it indicates a 2.0 d change from 0.04 lb to a steady indication of 0.06 lb.

6. If the scale passes this test at a load near zero, the test should also be performed near the maximum test load.

Figure 2: Test for discrimination at or near maximum load.



This example of a discrimination test near capacity is based on a scale division of 0.01 lb at a test load of 29.00 lb.

1. With the scale at zero, place decimal weights on the scale equal to 1.4 d, then zero the scale.

2. Add test weights to make the scale indicate a weight value near capacity (e.g., 29.00 lb).

3. With the scale stable, add decimal weights in 0.1 d increments until the indication flickers between 29.00 lb and 29.01 lb.
   - If the indication shows a steady 29.01 lb., remove 0.1 d.
   - If the scale indicates 29.00 lb it is at the breakpoint in the zone of uncertainty. (Replace the 0.1 d if it was used to verify the breakpoint.)

4. Remove the 1.4 d (0.014 lb) of test weights.

5. The scale passes if it indicates a 2.0 d change from 29.01 lb to a steady indication of 28.99 lb.